SOFIA Airborne Platform
Quality Assurance Plan

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REVISIONS

Revisions to the document from the previous issue are denoted by vertical bars in the margin of the page.

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-	12/01/08	Initial Release	

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1.0 PURPOSE

This Quality Assurance Plan (QAP) complies with NPD 8730.5, NASA Quality Assurance Policy. It is a risk-based tailoring of the Center's AS9100 certified Quality Management System that defines the quality approach and responsibilities for the SOFIA Airborne Platform Project.

The primary objective of this plan is to minimize the Project's risk that material, process and hardware problems will jeopardize safety, technical, cost and schedule performance. This is accomplished by focusing on:

- Implementation of robust work processes that eliminate potential problems, before they occur.
- Detection of problems at the earliest possible stage.

2.0 SCOPE

This Plan covers Flight Hardware, and interfacing Ground Support Equipment, during all phases of the SOFIA Airborne Platform Project, including design development, fabrication, integration, conformity verification, and validation during flight tests and observatory operations.

This Plan applies to all organizations performing work in support of the SOFIA Airborne Platform Project. It also addresses the interface with Suppliers of key goods and services. Suppliers (see Definition) include any U.S. or international commercial, non-profit or Government entity that delivers hardware or services for SOFIA – including MOU / MOA partners.

The hardware aspect of programmable firmware is covered in this Plan, while QA of the software aspect is defined in the Project SQA Plan (SOFAP-DRC-00003-PLN).

3.0 PROJECT DESCRIPTION

The Stratospheric Observatory for Infrared Astronomy (SOFIA) is an airborne observatory that supports studying the universe in the infrared spectrum. In addition to its support of astronomical science, SOFIA will be a major factor in the development of new observational techniques and instruments. SOFIA's scientific advances will stimulate educational opportunities for young scientists and teachers in the discipline of infrared astronomy.

NASA and the DLR (German Aerospace Agency) are working together to create SOFIA — a NASA 747SP aircraft, modified by L-3 Communications Integrated Systems to accommodate the DLR's 2.5-meter reflecting infrared telescope, and delivered to NASA for final modifications.

SOFIA will be the largest airborne observatory in the world, and will make observations that are impossible for even the largest and highest ground-based telescopes. Customers include scientists and universities sanctioned by NASA Headquarters in conjunction with the wider scientific community.

SOFIA will be maintained and operated as a "Public-Use" aircraft using Federal Aviation Regulations as guidelines.

The SOFIA Program consists of two projects: the Airborne Platform Project and the Science Project. Any unique QA requirements for the Science Project are addressed in the Science Project Safety and Mission Assurance Plan. Hereafter, the SOFIA Airborne Platform Project will be referred to as the "Project."

4.0 APPROACH

This Plan risk-tailors QA activities, including selection and verification of materials and processes; qualification, audit and surveillance of key suppliers; qualification and control of key processes during fabrication and installation; systematic verification of product conformity to requirements; and the generation of traceable conformity records.

The primary focus is on problem prevention and, failing that, early detection – to minimize the impact on safety, cost and schedule.

Supporting this QA Plan are contract Statements of Work (SOW), Supplier Statement of Requirements (SSOR), procurement quality attachments, surveillance plans, supplier and internal process and product audits, and other quality processes and documentation required by NASA Headquarters and DFRC policies.

4.1 Customer Relationship

The Observatory serves the scientific community, and Program and Science Project level communication with that customer community is anticipated. The Airborne Platform Project shall meet Program approved Science Project requirements. In addition, due to the planned role of the SOFIA Observatory as an Education and Public Outreach entity, many features important to the public in commercial airlines have been retained, such as standard airline seating, adequate lavatories, galley/food storage, emergency oxygen, seating access, public address system, and emergency egress. In this regard, the project has retained those features from the original 747SP necessary for flight under NASA certification.

4.2 Telescope and Science Instrument Partners

For the Telescope Assembly and Science Instruments, the Project's QA approach will:

- Focus on detection and correction of issues that can affect airworthiness.
- Focus on Quality Assurance of new work, including:
  - Receiving inspection – e.g. new articles, upgrades, returned rework, etc. for the Telescope Assembly and Science Instruments.
  - Liaison participation in test and check-out activities.
  - Liaison participation in the disposition of identified problems, and acceptance of nonconforming hardware.

4.3 Role of QA Personnel in Project Activities

The Project bears primary responsibility for ensuring compliance with all engineering and quality assurance requirements, including identification of critical or complex tasks, supplier quality assurance, test witnessing, product verification inspections, material certification, special processes, control of records, and Government mandatory inspections.

Quality Assurance personnel assigned to the Project are funded in large part by the Project. Their tasks are coordinated with other Project activities and their goal is to ensure Project success. However, Quality Assurance is an independent organizational entity that represents the wider NASA enterprise and is not subordinate to the Project.

The Project's Work Breakdown Structure (WBS), identification of tasks, staffing, and other appropriate resources are provided and coordinated with the Project through the Project's governing documents, including the Management Plan, Master Schedule, and Configuration Management Plan.

4.4 Continuous Risk Management

Throughout the Project life cycle, significant risks shall be identified, documented, analyzed, mitigated, reported and closed in accordance with the Risk Management Plan SOF-1068.

Project-unique safety risks include the in-flight presence of international scientific teams, and other members of the public.

Principal new technology risks for the Project include:

- Significant modifications of the airframe.
- Use of a complex infrared telescope assembly with special coated mirrors and peripheral support equipment.
- Specialized Observatory components potentially allowing direct flight commands for flight course corrections through modified avionics components.

4.5 Quality-Related Project Objectives and Requirements

A SOFIA Supplier Statement of Requirements (SSOR) shall compile the supplier quality assurance requirements of the Airborne Platform.

Engineering is responsible for the formulation of activities necessary to verify and validate compliance through test, inspection, demonstration, or analysis.

At its discretion, Project Quality Assurance shall participate in, witness, or monitor key activities to confirm compliance as directed in this plan. Those activities include Design Reviews, Engineering/Management meetings, Project Control Board (PCB), supplier qualification, audit and surveillance, aircraft inspections, in-process audits, Government Industry Data Exchange Program (GIDEP) monitoring, witnessing or monitoring tests, non-conformance reviews, and problem or corrective action system monitoring.

5.0 CHANGE AUTHORITY

This QA Plan is a Project-level governing document. Any changes shall be coordinated through the Airborne Platform Quality Assurance Specialist and submitted to the PCB in accordance with the SOFIA Configuration Management Plan, SOFAP-DFC-00001-CMP.

6.0 APPLICABLE DOCUMENTS

The following requirements documents are addressed by this Project QA Plan:

Federal Acquisition Regulation (FAR)

Federal Aviation Regulations

NASA FAR Supplement (NFS)

Title 14, Code of Federal Regulations (14 CFR)

ISO 9001:2000 Quality Management Systems

AS9100 Quality Management Systems - Aerospace - Requirements

AS9102 Aerospace First Article Inspection Requirement

AS9103 Variation Management of Key Characteristics

AS9131 Quality Systems Non-Conformance Documentation

NPR 6000.1 Requirements for Packaging, Handling, and Transportation For Aeronautical and Space Systems, Equipment, and Associated Components

NPR 7120.5 NASA Program and Project Management Processes and Requirements

NPD 8070.6 Technical Standards

NPD 8700.1 NASA Policy for Safety and Mission Success

NPR 8705.6 Safety and Mission Assurance Audits, Reviews, and Assessments

NPD 8710.5 NASA Safety Policy for Pressure Vessels and Pressurized Systems

NPR 8735.2 Management of Government Safety and Mission Assurance Surveillance Functions for NASA Contracts

NPD 8730.5 NASA Quality Assurance Program Policy

NPR 8715.3 NASA Safety Manual

NPD 8730.1 Metrology and Calibration

NASA STD 8739.1 Workmanship Standard for Staking and Conformal Coating of Printed Wiring Boards and Electronic Assemblies

NASA STD 8739.2 Workmanship Standard for Surface Mount Technology

NASA STD 8739.3 Soldered Electrical Connectors

NASA STD 8739.4 Crimping, Interconnection Cables, Harnesses, and Wiring

NASA STD 8739.5 Fiber Optics Terminations, Cable Assemblies, and Installation

6.1 Order of Precedence

In the event of a requirements conflict, the order of precedence is defined in the Project's Configuration Management Plan SOFAP-DFC-00001-CMP.

6.2 Requirements Tailoring

Tailoring of design documentation requires approval of a Deviation/Waiver in accordance with the Project's Configuration Management Plan SOFAP-DFC-00001-CMP.

Tailoring of the requirements imposed by standards, or a performing organization's procedures and processes (other than design documentation) shall be submitted prior to implementation for approval by the PCB. The Project shall document and control these exceptions, and the tailoring of governing documents or standards. Project exceptions and tailoring can be found in the Airborne Platform Project Plan.

7.0 DEFINITIONS

Airworthiness	Condition resulting from compliance with requirements during the manufacture process, environmental testing, and functional tests, and verified by inspection and/or analysis to be safely used for flight.
Anomaly	An unconfirmed or potential failure requiring further investigation prior to acceptance.
APU	Auxiliary Power Unit
CFR	Code of Federal Regulations
CMP	Configuration Management Plan
Code SQ	DFRC Quality Assurance Office

Complex item	An assembly of individual parts, all of whose attributes can no longer be verified as conforming to specified requirements. Common usage includes complex work, complex item list, etc.
Component	An assembly or any combination of parts, subassemblies, or assemblies mounted together, such as a transmitter or cryogenic pump.
COTS	A Commercial Off The Shelf item has already been developed, and is available for purchase.
Critical	Failure to comply with prescribed requirements can result in loss of life, serious personnel injury, loss of mission, or loss of a significant mission resource. Common usage includes critical work, critical process, critical attribute, critical item, etc.
Deviation/Waiver	A written concession by the Project to depart from specified requirements. Deviation is a planned departure. Waiver is a discovered (unplanned) departure.
DFRC	NASA's Dryden Flight Research Center
Discrepancy	See Non-conformance.
DLR	The German Space Agency
DR	The Discrepancy Report is a problem-tracking record for hardware and software.
EEE Parts	Electrical, Electronic, and Electromechanical articles
Environmental Test	Procedure to systematically subject an item to conditions that it will experience under operational use or storage with some reasonable safety margin added.
FAI	First Article Inspection
Failure	The inability of a system, subsystem, component, or part to perform its required function within specified limits, under specified conditions for a specified duration.
FAR	Federal Acquisition Regulation
FCA	Functional Configuration Audit
First Article	The first unit produced that is intended to meet all specified requirements and customer applications.
FMEA	Failure Modes and Effects Analysis of a system and the working interrelationships of its elements to determine ways in which failures can occur (failure modes) and the effects of each potential failure on the system element in which it occurs, on other system elements, and on the mission.
Formal Test	Any test where passing is a criterion for determining that a product is airworthy (e.g. Environmental, Verification, Combined Systems Test)
GFE	Government-furnished equipment, intellectual property, etc.
GIDEP	Government Industry Data Exchange Program
GMIP	Government Mandatory Inspection Point (e.g. product examination, process witnessing, record review, etc.) where a product assurance

	action must be performed by Project Quality Assurance or its delegated representative.
Hazardous Operation	Any operation involving material or equipment that has a high potential to result in loss of life, serious injury to personnel, or damage to systems, equipment, or facilities.
Key Characteristic	Feature of a material, process, or part whose variation has a significant influence on product fit, performance, service life, or manufacturability.
MCCS	Mission Control and Communications System
MOU / MOA	Memorandum of Understanding / Agreement
MRB	The Material Review Board evaluates and dispositions non-conforming articles.
NALCOMIS	Naval Aviation Logistics Command/Management Information System
NDE	Non-Destructive Examination (e.g. radiography, dye penetrant, etc.)
NFS	NASA FAR Supplement
NODIS	NASA Online Data Information System. Document Management System holding NASA policy and requirements located at: http://nodis.hq.nasa.gov/
Non-Conformance	Some part of a material, article, process, or service that does not satisfy specified requirements. These include failures, discrepancies, defects, and malfunctions.
NPD	NASA Policy Directive
NPR	NASA Procedural Requirement
PCA	Physical Configuration Audit
PCB	Project Control Board
Project QA	Project Quality Assurance is the Government civilian(s) designated by Code SQ to coordinate the Project's QA Program.
PQASP	The Program/Project Quality Assurance Surveillance Plan is the defined approach for monitoring and verifying supplier conformance to contract requirements for deliverables – as prepared by the COTR and assigned Project Quality representative(s).
QAP	Quality Assurance Plan
QAR	The Quality Assurance Representative is a contractor, or other Government agency, designated by Project Quality Assurance.
QMS	A Quality Management System includes those policies, practices, competencies and facilities that cause a product or service to meet requirements.
Qualification Test	Exposure of a unit to conditions beyond its intended capabilities – which can be destructive, including the possibility of latent defects.
R&M	Reliability and Maintainability

Redline	An at-risk change to a requirements document that is approved after an abbreviated review in accordance with the CM Plan – to facilitate rapid return to work.
Reliability	The probability that an item will perform its intended function for a specified interval under stated conditions. The function of an item may be composed of a combination of individual sub-functions to which the top-level reliability value can be apportioned.
Repair	Additional authorized processing that restores a non-conforming product to a use-as-is condition – which does not comply with the original specified requirements.
Rework	Additional authorized processing that restores a non-conforming product to a condition that fully conforms to all drawing, specification, and contract requirements.
SDP	Software Development Plan
Shall	Compliance is mandatory.
SOFIA	Stratospheric Observatory for Infrared Astronomy
Special Process	Any process where the conformity of the resulting product cannot be readily or economically verified. Process parameters are qualified, documented and controlled, and/or personnel are certified based on demonstrated proficiency. Activities like welding, handling ESD sensitive devices, clean room operation, and Non-Destructive Examination (e.g. radiography) are treated as special processes.
SQA	Software Quality Assurance
SSOR	Supplier Statement of Requirements
Supplier	Any U.S. or international commercial, non-profit or Government entity that delivers hardware or services for SOFIA – including MOU / MOA partners.
Surveillance	The monitoring and verification of supplier conformance to contract requirements for deliverables. May include process audits, records reviews, product witness inspections, participation in technical reviews, etc.
Troubleshooting	A procedure for localizing and diagnosing equipment malfunctions or anomalies, typically by a systematic examination progressing from higher to lower levels of assembly.
Use-As-Is	The authorized use of product that does not comply with the original specified requirements.
Verification	Proof of compliance with drawing and/or specifications. Determination may be by a combination of test, analysis, demonstration, record review, and/or inspection.
WBS	Work Breakdown Structure
Witness	Present from start to finish including set-up and verification of results of the test or operation with observation of the tests/subtests or operation.

8.0 DOCUMENTATION AND RECORDS

The design, fabrication, assembly, inspection and testing of Flight Hardware and interfacing Ground Support Equipment shall be performed in accordance with approved documented procedures, work orders, travelers, drawings and their referenced specifications.

Records shall be generated as evidence of conformity to requirements, and shall be legible, readily identifiable, and retrievable.

Records relating to the SOFIA Project shall be controlled by the Project – or as agreed with suppliers. This includes drawings, test and checkout procedures, part control tags, serviceable tags, aircraft workbook documentation, receiving inspection documentation, etc.

Electronically generated and maintained records on a controlled database within the performing organization's quality system are acceptable.

9.0 CONFIGURATION MANAGEMENT

Release and change control of SOFIA Project documents shall be in accordance with the Project's Configuration Management Plan (CMP), SOFAP-DFC-00001-CMP.

9.1 Fast Track Document Changes

When essential to facilitate a rapid return to work, at-risk revision of Project documentation is permitted:

- Revisions to Work Orders will be accomplished per DCP-O-002, Section D.
- Revisions to drawings will be accomplished per DCP-O-004, Section 7.0 except instrumentation system drawings which will be redlined per DCP-R-409.
- Revisions to test procedures and checklists will be accomplished per DCP-O-011, Section 4.0
- Project configuration controlled specifications and documents will be revised per the project CM Plan referenced above.

9.2 Hardware Part Substitutions

When essential to facilitate a rapid return to work, at-risk part substitutions can be made by redlining the applicable drawing, procedure, etc. and initiating the formal change authorization as defined above. Each substitute part number and its location shall be recorded in the aircraft workbook and approved by Operations Engineer. For project controlled items a formal change authorization through the Platform Project's Project Control Board will be initiated.

10.0 GOVERNMENT MANDATORY INSPECTION POINTS (GMIPs)

GMIPs are QA actions performed or witnessed by Project Quality Assurance, or its delegated QA Representative, including product examination, process evaluation, records review, etc.

Work Authorizing Documents shall be reviewed, and GMIPs established, by Project Quality Assurance in accordance with DCP-S-019 entitled Product Assurance.

Project Quality Assurance specifies GMIPs at appropriate points in supplier and internal fabrication, assembly, inspection and test procedures to ensure the compliance of safety or mission critical attributes – as required by NPD 8730.5, the NASA Quality Assurance Program policy. Safety/mission critical attributes include hardware characteristics, manufacturing

process requirements, operating conditions, and functional performance criteria that if not met could result in loss of life or loss of mission.

GMIPs reflect various Project risk analyses (e.g., probabilistic risk assessments, hazard assessments, hazard analyses, failure modes, effects analysis and critical/complex item lists). They are imposed at the latest operation where verification is possible prior to cover-up and shall be:

- As late as practicable in a process where attributes can be altered, and
- As early as practical when attributes cannot be subsequently altered.

GMIPs shall not be waived, nor GMIP criteria modified, except as approved by Project Quality Assurance.

11.0 PROCUREMENT QUALITY ASSURANCE

Procurements of Flight Hardware, interfacing Ground Support Equipment and related technical services by NASA and their support contractors shall be reviewed by Project Quality Assurance before execution. Such procurements include contracts, credit card buys, purchase orders, MOUs / MOAs, etc.

Project Quality Assurance shall review procurement documents to ensure:

- Procured articles and services are adequately defined – including drawings, specifications, standards, etc. and their applicable revision levels.
- Inclusion of appropriate Federal Acquisition Regulations (FAR) Part 46 and Part 52, Quality Attachments/clauses, pre-award and post-award audits, source inspection requirements (including Government Mandatory Inspection Points, in-process inspections, special process, etc.).

11.1 Used Product

Before delivering any article produced with used, re-manufactured, or otherwise refurbished items, suppliers shall obtain the written approval of Project Quality Assurance through the NASA Contracting Officer.

11.2 Commercial Off-the-Shelf (COTS) Items

Orders for commercial items generally rely on the supplier's existing quality system as a substitute for Government inspection and testing. Any in-process inspection by the Government will be conducted in a manner consistent with commercial practice.

If the Project purchases COTS hardware or software and subsequently modifies the item, it shall be processed as required by the respective SOFIA Project Configuration Management or Software Development Plan.

11.3 Packaging/Shipping Requirements

Packaging, packing, marking, handling, preservation and transportation shall be in accordance with NPR 6000.1 and:

- As defined in contracts, P.O.s, MOU/MOAs, etc. for product design and development.
- Per applicable drawings and referenced specifications for build-to-print fabrication.
- Per best commercial practice for COTS items.

11.4 Qualification of Suppliers

Suppliers of Flight Hardware, interfacing Ground Support Equipment and related technical services shall be qualified by Project Quality Assurance before award. Qualification requirements shall be risk tailored (based on the criticality and complexity of the articles and services being procured) and include one or more of the following:

- Documented record of acceptable performance on recent, comparable DFRC orders.
- On-site audit of the supplier's quality system for compliance to the appropriate quality system standard (e.g. AS9003, ISO 9001, AS9100, ISO 17025) – as defined in NPDs 8730.5 and 8730.1.
- Recent acceptable audit reports in NASA's Supplier Assurance System (SAS) database for the same scope of supply.
- Evidence of a current third party quality system certification.

11.5 QA Requirements for Supplier Implementation

Project Quality Assurance shall ensure that NASA and support contractor procurement documents include appropriate quality assurance requirements for implementation by the supplier. These requirements shall be risk-tailored by Project Quality Assurance based on 1.) Criticality and complexity of the procured articles and services, and 2.) Supplier-specific risks identified during supplier qualification activities, subsequent performance, etc.

Such supplier QA requirements include:

- Implementation of a quality system that complies with AS9003, ISO 9001, AS9001, ISO 17025, etc.
- Certification of key processes and personnel to NASA workmanship standards.
- Implementation of controls in accordance with defined technical standards (e.g. clean rooms, ESD, etc.)
- Inspection / test in accordance with specified sampling plans (e.g. ANSI/ASQ Z1.4, General Inspection Level II, 1.0 AQL, Single Sampling Plan, Normal Inspection).
- Submission of First Articles for Government witness inspection.
- Delivery of process control charts, inspection and test reports, etc.

11.6 Certificates of Conformance

Certificates of Conformance shall include such key information as:

- Identification of the delivered drawing/part numbers.
- Identification of the delivered lot and/or serial numbers.
- Reference to the contract, purchase order or other requirements being certified.
- Reference to specific relevant inspection/test records.
- Name, title, signature and date of the certifying authority.

As appropriate, Project Quality Assurance shall provide suppliers with a template for an acceptable Certificate of Conformance.

11.7 Government Surveillance Rights

Project Quality Assurance shall ensure that procurement documents reserve the Government's right to audit, review, inspect, measure, witness, test, or otherwise verify supplier and

sub-tier supplier compliance. The primary objective is to assure compliant products are delivered – without cost and schedule impacts caused by supplier errors, omissions and remedial actions.

11.8 Supplier Surveillance Plan

Upon the award of key contracts, Project Quality Assurance in coordination with the NASA Contracting Officer shall develop a Project Quality Assurance Surveillance Plan (PQASP) as required by Federal Acquisition Regulation (FAR) Part 46, NASA FAR Supplement 1846, and NPR 8735.2A. As the contractual relationship matures between the Government and supplier, Project Quality Assurance shall update the plan as required.

The surveillance plan shall be risk-tailored based on 1.) Criticality and complexity of the procured articles and services, and 2.) Supplier-specific risks identified during supplier qualification activities, subsequent performance, etc. The plan shall define how the Project will monitor supplier performance – for example:

- Periodic quality system audits during an extended period of performance.
- Review the qualification of key sub-suppliers.
- Review the qualification of key production & NDE processes.
- Process audits.
- Witness inspections and tests.
- Review contract deliverable documents.
- Review Hazard Reports, ECOs, Nonconformance Reports, etc.
- Participate in milestone reviews (e.g. CDR, TRR, etc.).
- Monitor metrics for patterns of commonality and trends over time.

11.9 Delegation of Surveillance Activities

If supplier quality assurance activities are delegated to another Federal agency or to a support contractor, the NASA DFRC Quality Assurance Office is responsible for ensuring that delegated functions are properly and effectively performed in accordance with a letter of delegation or task to the support service contract.

11.10 Receiving Inspection Requirements

Project Quality Assurance shall ensure that receiving inspection requirements are risk-tailored. Based on criticality, complexity, and the level of confidence in the supplier's quality system, receiving requirements shall include one or more of the following:

- Verification of correct identity and quantity, and absence of visible damage.
- Verification that the source is a DFRC qualified supplier.
- Screening of received part numbers / lot numbers against the GIDEP database of problem reports.
- Verification that data in certified material test reports conforms to material specifications.
- Product, processing and NDE compliance certificates are present and correct.

- Verification that supplier's submitted inspection and test reports show compliance to applicable drawings and specifications.
- Product inspection for drawing / specification compliance, in accordance with a defined sampling plan.

12.0 PROCESS CONTROL / PRODUCT ASSURANCE

Whether outsourced, or performed internally, the Project shall ensure the quality of Flight Hardware and interfacing Ground Support Equipment as follows:

- Process Evaluation – Assess the capability, and planned controls, for key processes (fabrication, integration, test, NDE and inspection).
- Procedure Evaluation – Review documented procedures for key operations, tests, etc. to ensure flow down of requirements, to ensure that the producer's planned QA activities are adequate, and to identify GMIPs.
- Product Examination – Products shall be physically inspected, measured, or tested to ensure conformity to requirements, including appropriate Government witnessing.
- Records Review – Evaluate records to ensure adequate evidence of conformity to product and process requirements.

12.1 Critical and Complex Item Lists

Critical and Complex Item Lists (CCILs) are normally identified in the planning stages of a Project – in part to guide the identification of GMIPs. Critical items are those having a significant influence on product fit, performance, service life, or manufacturability, and where non-compliance can result in loss of life and/or mission. CCILs are how the Project will achieve the "key characteristics" objectives of AS9100.

Project Quality Assurance shall ensure that a Critical/Complex Item List is developed (ref: NPD 8730.5). For each CCIL item a Product Quality Plan shall be developed, covering the product's life-cycle, including:

- Quality Requirements for Supplier Implementation
- Qualification of Supplier
- Supplier Surveillance Activities
- Product Acceptance
- Storage, Testing, Installation, Operation and Maintenance

Each Product Quality Plan will tailor and schedule the specific types of quality assurance activities appropriate for each CCIL item – see the Product Quality Plan template in Appendix A.

Presently, the Airborne Platform Project is in the execution phase. To avoid missing key problem prevention opportunities, Project Quality Assurance is actively identifying GMIPs for complex items as new procurements are identified (e.g. Auxiliary Power Unit (APU) ducting, Liquid Nitrogen and Mission Control and Communications [MCCS] system.).

12.2 Documented Procedures and Processes

The fabrication, integration, inspection and testing of Flight Hardware and interfacing Ground Support Equipment by DFRC personnel shall be performed in accordance with approved work orders, travelers, procedures, test plans, drawings, referenced specifications, etc.

The Responsible Engineer, Operations Engineer and Project Quality Assurance shall review and approve all such work authorizing documents. Project Quality Assurance shall ensure that risk-tailored QA requirements are included, such as:

- Certification of key processes and personnel.
- Definition and implementation of process controls (e.g. clean rooms, ESD, etc.).
- Inspection / test in accordance with specified sampling plans (e.g. ANSI/ASQ Z1.4, General Inspection Level II, 1.0 AQL, Single Sampling Plan, Normal Inspection).
- Submission of First Articles for witness inspection.
- Unambiguous pass/fail criteria.
- Data recording requirements (e.g. expiration dates, torques, etc.).
- Provision of process control charts, inspection and test data, etc.

12.3 Training and Certification

Key activities shall only be performed by trained personnel who have demonstrated sufficient proficiency to become certified.

These include those activities identified in DCP-O-001, entitled Aircraft Maintenance & Safety Manual, Chapter 3 – Qualifications and Training. In addition, performing personnel shall be certified to the following workmanship standards:

- NASA STD 8739.1, Staking and Conformal Coating of Printed Wiring Boards and Electronic Assemblies.
- NASA STD 8739.2, Surface Mount Technology.
- NASA STD 8739.3, Soldered Electrical Connections.
- NASA STD 8739.4, Crimping, Interconnecting Cables, Harnesses, and Wiring
- NASA STD 8739.5, Fiber Optic Terminations, Cable Assemblies, and Installation

12.4 Hazardous Operations

Procedures that involve Hazardous Operation(s) shall be conspicuously identified on the cover page of the relevant procedure. Warnings and Cautions shall be identified prior to the work steps that perform the hazardous operation. Procedures that involve hazardous operations require Safety Representative approval, in addition to other signature requirements.

12.5 Tethering

When operations are accomplished above the Telescope Assembly, or at elevated distances above aircraft surfaces, tools and/or equipment shall be tethered in such a manner that accidental dropping does not result in the item making contact with the T/A or aircraft.

12.6 Electrostatic Discharge (ESD)

To preclude invisible damage and latent failures in electronic components and circuit boards, personnel training, work station control, product packaging and handling practices shall be in accordance with DOP-O-025, entitled ESD Control Program.

12.7 Lifting Devices

All hardware lifting operations shall comply with NASA STD 8719.9, Standard for Lifting Devices and Equipment, or an equivalent standard approved by Project Quality Assurance. Lifting of major components and structures shall be treated as a Critical Lift and shall comply with DOP-S-019, Chapters 6 and 7.

12.8 System Cleanliness Requirements

Articles shall be maintained clean in accordance with requirements defined in applicable drawings/specifications. Specific cleanliness practices shall be defined in procedures, work orders, travelers, test plans, etc. and approved by Project Quality Assurance.

If the drawing, procedures, work orders, etc. do not identify contamination control requirements, standard aviation cleanliness practices apply.

12.9 Pyrotechnics

Quality attachment Q17 shall be applied to procurements of pyrotechnics. Pyrotechnics shall be received, handled, stored, and tested in accordance with DCP-S-012 and shall follow the requirements of AFM 91-201 and NASA Standard NSS-1740.12. Project Quality Assurance shall apply Tamper Indicator(s) to critical pyrotechnic connections and access covers.

Organizations assembling and installing pyrotechnics shall inform Project Quality Assurance sufficiently before the operation commences – to ensure access, and to permit close-out photos when appropriate.

12.10 Optical Components

Devices with exposed optical surfaces shall not be received or processed without written requirements for handling and preservation – notify the SOFIA Instrumentation Lead before proceeding.

12.11 Tamper Indicators

The use of tamper indicators shall be controlled:

- Quality Seals shall be stamped by Project Quality Assurance.
- Colored connector/fastener seals are reserved for Project Quality Assurance.
- Hardware with tamper indicators shall not be disturbed or opened without Project Quality Assurance present, or with their consent.
- A Logbook and/or Naval Aviation Logistics Command/Management Information System (NALCOMIS) entry shall be made when tamper indicators are disturbed. Disposition is reserved for Project Quality Assurance and the Operations Engineer.

12.12 Close-Out Photographs

Close-out photographs, such as avionic boxes and systems, shall be taken in accordance with DOP-O-008.

Close-out photographs shall also be taken of Repair and Use-As-is dispositions (see Definitions) before they are closed off or become inaccessible.

12.13 Internal Audits

Internal audits shall be conducted on key Project processes and hardware to verify that the quality system effectively achieves product quality. The internal audit programs managed by Code SQ and the Management Systems Office shall be coordinated – to ensure optimum coverage for the Project. Audits shall be scheduled, performed and reported in accordance with DCP-S-006, entitled Quality Assurance Audits and DOP-X-002, entitled DMS Audit Preparation and Execution.

12.14 Metrology / Calibration

Calibrated devices shall be used for all operations, inspections and tests performed on Flight Hardware and interfacing Ground Support Equipment. These monitoring and measuring devices shall be selected, used, controlled and calibrated in accordance with DCP-S-055 entitled Metrology System.

To permit traceability (if a device is found to be out of tolerance at a subsequent calibration) device serial numbers shall be recorded:

- In the "Work Items Results" block of Work Orders.
- In the aircraft workbook or NALCOMIS.

12.15 Government-Industry Data Exchange Program (GIDEP) and NASA Advisories

To preclude use of failure prone or counterfeit articles/lots, Project Quality Assurance shall:

- Ensure that procured articles are screened upon receipt for applicable GIDEP reports (e.g. Alerts, SAFE-Alerts, Problem Advisories, Agency Action Notices, and Diminishing Manufacturing Sources and Material Shortage) and NASA Advisories.
- Receive and review new GIDEP reports and NASA Advisories to determine applicability to in-stock or installed SOFIA part numbers and lot numbers.

If a GIDEP match is confirmed, Project Quality Assurance shall initiate a Form D-WK 605-7 (ODT5-Aircraft Maintenance Discrepancy/Work Record) to facilitate the systematic disposition of suspect articles.

Project Quality Assurance shall also initiate appropriate reports (GIDEP, Lessons Learned, NASA Advisories, etc.) to communicate failed or non-conforming items found by the Project.

Similar practices shall be required of suppliers in their contracts, purchase orders or MOU/MOAs.

12.16 Electrical, Electronic, and Electromechanical (EEE) Parts

EEE parts selection, testing and application shall be performed in accordance with DCP-S-048, Appendix E entitled EEE Parts Plan. Supporting technical requirements and guidance are contained in other sections and appendices of DCP-S-048.

12.17 Limited Life Items

Limited life Items have a limited operating life, limited shelf life, are operating life sensitive or a combination of these factors.

When incorporated into Flight Hardware or interfacing Ground Support Equipment, limited life items shall have their expiration dates/limits recorded in the applicable traveler, work order, log book, etc.

To authorize extension, the extension limits and technical rationale shall be documented and approved by Operations Engineering:

- Articles fabricated by DFRC – documented in the applicable Work Order.
- Articles overhauled / refurbished by DFRC – documented on the Parts Control Tag.
- Work performed on the aircraft – documented on form D-WK 605-7 (ODT5-Aircraft Maintenance Discrepancy/Work Record).

Where the future replacement of installed limited life items is applicable, the Operations Engineer shall systematically track their expiration dates/limits to facilitate timely notification and replacement.

12.18 Workmanship Criteria

Workmanship criteria for outsourced or internally developed electrical/electronic designs shall be in accordance with the applicable NASA Workmanship Standards (e.g. solder, conformal coating, etc.).

Modifications to COTS electrical/electronic hardware shall be in accordance with the relevant NASA Workmanship Standards.

Mechanical workmanship criteria are as specified in product drawings and referenced specifications.

Suppliers wishing to apply workmanship criteria other than those contractually specified shall submit a waiver/deviation for Project Quality Assurance approval.

12.19 Product Specification and Tolerancing

Product physical and functional attributes shall be specified in terms of unambiguous acceptance criteria in design drawings, specifications, test procedures, etc. With the exception of digital, binary test responses, the nominal design value and the acceptable range shall be specified for each attribute. For product drawings, ASME Y14.5 Dimensioning and Tolerancing is the preferred standard.

13.0 INSPECTION, TEST AND NON-DESTRUCTIVE EXAMINATION

The conformity of Flight Hardware and interfacing Ground Support Equipment to its authorized physical and functional configuration shall be verified by systematic, documented inspections, tests and non-destructive examinations. These shall include first article, source, receiving, in-process and final inspections; destructive tests; NDE; and qualification, environmental and functional tests, etc.

Each product's authorized physical and functional configuration is defined in formally released and revision controlled bills of material, drawings and their referenced specifications (e.g. specs for materials, processing, NDE and packaging, etc.); performance specifications and test plans / procedures; and approved variances (e.g. discrepancy reports, deviation/waivers, etc.).

Functional Configuration Audits typically include tests that verify product conformity to specified performance requirements. They are generally conducted after Physical Configuration Audits have verified product conformity to specified physical requirements.

Physical Configuration Audits may include: 1) Destructive tests for chemical and physical properties (e.g. tensile strength, etc.), 2) Product inspections that verify conformity to speci-

fied shape, size and processing (e.g. anodizing, etc.) and 3) Non-destructive examinations, such as radiography, for attributes like structural integrity (e.g. freedom from cracks, etc.).

Physical Configuration Audits have two mirror-image objectives:

1. Verify that as-built hardware conforms to its authorized physical configuration requirements, including any approved variances, and
2. Verify that the authorized configuration documents (including approved variances) accurately reflect the actual physical configuration of the as-built hardware.

Beginning at the Critical Design Review stage, Project Quality Assurance shall identify individual GMIPs when reviewing supplier and internal design, production and verification planning documents, including subsequent detailed inspection and test plans and procedures.

Each formal test shall be documented, with defined acceptance criteria. Test results shall be recorded in the test document adjacent to the applicable step or sequence. Project Quality Assurance shall review and witness the tests as appropriate.

13.1 Statistical Sampling

Product inspections and tests shall be performed using one or more plans selected from ANSI/ASQ Z1.4 entitled Sampling Procedures and Tables for Inspection by Attributes. If a specific plan has not been specified, ANSI/ASQ Z1.4, General Inspection Level II, 1.0 AQL, Single Sampling Plan, Normal Inspection shall apply.

Note: ANSI/ASQ Z1.4 is a family of dozens of lot inspection plans, each one based on a different level of "false accept vs. false reject" sampling risk. If a lot size is too small to satisfy the built-in risk criteria, each plan will automatically specify 100% inspection / test.

13.2 Test Readiness Review (TRR)

The performing organization shall conduct a TRR for each formal test, mating, integration, or moving operation. The TRR shall review all associated documentation to ensure the operation is ready to proceed.

Using Test Readiness Review Checklist APP-DF-LIS-SE04-2000, the following items should be considered, and supporting records made available:

- Receiving inspection results
- Assembly/inspection/test operations are complete
- Discrepancies/inspection findings are identified
- Related discrepancies are closed with meaningful corrective actions
- Aircraft workbook/NALCOMIS
- Configuration list for the item(s) involved has been verified
- Test integrity
- Documented procedures are available
- Markings are proper, accurate, and legible
- Personnel and equipment certifications are current (crane operators, lifting device proof tests, etc.)
- Test equipment is calibrated
- Project representatives are ready and available for duration
- Photos to be taken (Mandatory for Qualification test items)

13.3 Source Inspections / Tests

Project Quality Assurance shall ensure that GMIPs cause key supplier inspections and tests to be witnessed – to verify conformity to applicable contracts, drawings and specifications. These may include First Article, key in-process and final acceptance inspections/tests.

To the extent possible, specific GMIPs shall be identified in purchase orders and contracts. For more complex design and development procurements, it may not be possible to establish GMIPs until the Critical Design Review defines the key tests, inspections and processing that may warrant Government verification.

Participation by the Project Chief Engineer, Operations Engineer may also be required to establish GMIPs. The Project Chief Engineer shall be primarily responsibility for witnessing functional aspects. The Operations Engineer shall be primarily responsible for ensuring environmental and airworthiness aspects are met.

Project Quality Assurance shall ensure that interface features such as mounting, weight, connector type/location/pin-out, materials, processing, workmanship and key characteristics as determined by a NASA design engineer, conform to specified requirements.

The results of source inspections and tests shall be recorded, including:

- Acceptance status (e.g. acceptance criteria, unambiguous accept/reject status, date, name of Government representative, etc.).
- Identification, tracking and closure of anomalies and discrepancies.

Tear-down inspection or retest is only warranted if the supplier fails to notify in time to witness an in-process inspection test or closeout of critical features. Tear-down inspection or retest may also be appropriate for suspect processes or potentially defective products. Before executing tear-down or retest, the supplier shall consult the Contracting Officer.

13.4 First Article Inspection and Test

First article inspections and tests shall be used, as appropriate, to verify physical and functional conformity to specified requirements before authorizing production of the balance of an order. Conformity verification of first articles minimizes the risk of:

- Cost and schedule impact due to rejection of a completed lot.
- Lot acceptance sampling.

13.5 Physical and Functional Configuration Audits

The extent and depth of physical and functional configuration audits shall be risk tailored – based on criticality, complexity, and the level of confidence in the supplier's quality system.

13.5.1 Functional Configuration Audit

Project Quality Assurance shall participate in functional testing, including first articles made by or for DFRC. A functional configuration audit shall be:

- Conducted in accordance with established configuration management procedures to verify that the unit's performance has achieved the functional requirements specified in the configuration documentation including specifications, drawings, requirements documents, etc.

- Comprehensive, and shall be performed to approved, released test procedures. Anomalies shall be recorded and sufficient analysis performed to determine if the unit has passed or failed the suspect criteria.

Test results shall be auditable – that is legible, repeatable, and complete.

In support of the functional configuration audit, NASA Software Quality Assurance (SQA) shall audit software products and processes in accordance with the SQA Plan. The Project Software Manager shall also audit software products and processes for compliance with the Software Development Plan (SDP). Typically, the supplier is audited to their SDP. Specific processes shall be included in the Project Software Quality Assurance Plan.

13.5.2 Physical Configuration Audit

Physical configuration audits shall be conducted to confirm that the physical characteristics of the unit (as-built configuration) comply with the relevant specifications, drawings, requirements documents – including specified materials, processing and NDE.

The hardware producer shall provide Government representative(s) with legible copies of drawings, specifications, material test and/or certification sheets, deviations and waivers, Use-As-Is and Repair non-conformances, and all other requested documentation related to the product.

Project Quality Assurance (or as designated by the Project with Project Quality Assurance concurrence) shall verify that the as-built product configuration conforms to the design authorized by the Project's configuration management system. Based on product criticality and complexity, the inspection may be performed by a team of experts such as operations, quality and discipline engineers; maintenance or other quality professionals. The team shall:

- Review material certifications.
- Review records showing qualification and control of key manufacturing processes.
- Verify that approved suppliers of Special Processes were used and that manufacturing planning/routing documents call out the correct process specifications.
- Verify that key monitoring and measuring devices were calibrated.
- Review non-conformance documentation for adequacy.
- Verify that all design attributes have inspection/test results verifying conformity.

Product(s) shall be measured and otherwise compared to each callout and note on design documentation. Each confirmed item, bullet, note or design aspect shall be highlighted or check marked to indicate compliance. Non-conformities shall be conspicuously marked (e.g. circled or marked in red). The document shall be signed on its face to show who performed the inspection. These drawings and referenced specifications shall be retained by the Project to facilitate follow up and closure of identified non-conformities.

The team lead shall provide the Project Manager with an audit report to communicate findings, and ensure closure of all open items affecting product(s). The team lead shall provide the original or reproducible copy of the report to the Project Control Board when complete.

13.6 Informal Tests

Project Quality Assurance need not witness informal tests, except in instances where the tests directly support formal test. For example, if an anomaly is observed during formal test, the performing organization shall invite Project Quality Assurance to witness informal tests

that demonstrate the anomaly was corrected. Repeating and passing formal test steps proves compliance otherwise.

13.7 Formal Test

Project Quality Assurance shall witness all formal tests – where passing is a criterion for determining that a product is airworthy. Items shall be tested to defined pass/fail criteria that are auditable, uniform, repeatable, and traceable to design documentation.

Project Quality Assurance shall be informed of any departures from test procedures, including sequence, unless the test procedure itself allows execution of subtests out of sequence.

During testing, test data and other records associated with the test shall be retained by Project Quality Assurance.

When a problem is identified, a Discrepancy Report shall be initiated describing the problem in sufficient detail to troubleshoot and resolve or correct the problem.

The Responsible Engineer assigned to respond to the Discrepancy Report shall ensure that timely actions are taken to remedy the deficiency, and that root cause identification and removal (i.e. corrective action) is also taken when warranted.

The organization performing the test shall provide ten (10) working days notification to Project Quality Assurance, allowing Project QA to exercise the option to witness and/or monitor the tests or inspections. If a test readiness review is not conducted, the Supplier shall otherwise ensure that the product, personnel and documented test procedures are ready for formal test. Upon request, the Supplier shall provide evidence and rationale to Project Quality Assurance that the product and staff are ready for test.

13.8 Operation Preconditioning (Burn-In Test)

Suppliers of flight electronics assemblies shall ensure that each delivered unit has achieved at least 100 hours of power-on, failure-free operation. Burn-in completion will be recorded on the history record tag, serviceability tag, or other deliverable conformity record associated with the product.

13.9 Final Acceptance

Final acceptance of Flight Hardware and interfacing Ground Support Equipment shall not occur until:

- All planned inspections and formal tests have been successfully completed, and
- Any anomalies or deficiencies have been documented and closed by the relevant Project authority.

In some cases final acceptance is not complete until formal test(s) are conducted at DFRC.

Project Quality Assurance reserves the right to witness or monitor inspections and tests and may elect to not participate in some activities, or may delegate some tasks to suppliers or other competent representatives. However, in such cases the supplier shall not proceed with the planned activity (except at supplier's risk) without written authorization from Project Quality Assurance.

14.0 CONTROL OF NONCONFORMING PRODUCT

When nonconforming Flight Hardware and interfacing Ground Support Equipment is identified during DFRC fabrication, installation, verification or use, it shall be logged, tagged, con-

trolled and its disposition authorized in accordance with the relevant sections of DCP-S-019, entitled Product Assurance

Contracts, purchase orders and MOU/MOAs shall require that suppliers secure the Project PCB's written concession before providing any article that does not meet documented requirements for product characteristics, material and processing – unless the supplier has a documented delegation of MRB authority that has been approved by the Project PCB, and has been received through the NASA Contracting Officer.

15.0 CORRECTIVE ACTION / PREVENTIVE ACTION

Corrective action and preventive action requests shall be initiated, analyzed for root cause, planned, tracked and verified to be effective in accordance with DCP-X-037.

15.1 Corrective Action

When product or process deficiencies have been remedied and additional action is warranted to eliminate underlying causes and preclude future similar problems, corrective action shall be initiated.

15.2 Preventive Action

Preventive action shall be initiated when:

- Hazard analyses, FMEAs, Fault Tree Analyses, etc. show potential problems with planned hardware or processes.
- Analysis of product and process records show patterns of commonality, or trends over time (i.e. improvement opportunities).

16.0 DATA ANALYSIS / METRICS

Managers and Leads responsible for key Project functions and processes shall analyze associated operating records, and monitor these metrics to identify problem common causes, trends over time, etc.

Data shall be regularly analyzed for the purpose of:

- Sharing analysis with Project and DFRC management – to identify quality trends and valuable areas for improvement.
- Adjusting the type or frequency of QA surveillance actions, including allocation of personnel resources.
- Providing confidence in the effectiveness of the Project's and supplier's quality system.
- Initiating preventive actions based on identification of systemic problems and trends.

Such data consists of records associated with configuration changes, verification analyses and inspections, validation tests, audit reports, Discrepancy Reports, MRB dispositions, log books, calibration results, GIDEP reports, etc.

17.0 GOVERNMENT FURNISHED EQUIPMENT

Government-furnished equipment, intellectual property, etc. (GFE) provided to users external to DFRC shall be identified and tracked by the Project Office. If GFE is provided to a commercial supplier, appropriate records shall be maintained by the Contracting Officer as required by the Federal Acquisition Regulation (FAR). If GFE is provided to other NASA centers, it shall be transferred on a DD250 in accordance with the NASA FAR Supplement.

Unless otherwise specified in the contract or written agreement with the Project, the GFE shall be maintained, calibrated, and protected by the possessing organization.

18.0 MISHAP RESPONSE

Mishap response shall be planned and executed in accordance with the SOFIA Mishap Response and Contingency Plan SOFAP-DFC-00005-SCP and DCP-S-001 entitled Aircraft Mishap Response.

19.0 PRINCIPAL CONTACTS

The Project shall identify principal contact information on an as-needed basis.

Only the NASA-DFRC Project Manager can execute the process for committing Government funds, facilities, equipment, information, or other resources and shall formally do so through the Project and governing NASA processes. Supplier questions in this matter shall be directed to the NASA Contracting Officer (or COTR, if delegated) with copies to the Project Manager.

(Appendix A Follows)

Prepared By:		
Approved By:		Kevin T. Reilly / SOFIA Chief Safety Officer
Approved By:		John F. Carter / SOFIA Project Manager

Rev	By	Description	Date
0	??	Initial Issue.	MM/DD/YY

Purpose and Scope

The XYX System has been identified as a Critical / Complex Item, in accordance with NPD 8730.5 – NASA Quality Assurance Program Policy and the SOFIA Airborne Platform QA Plan. Major sub-systems include

Note: Section numbers XX and YY of this plan do not apply to the current contract (if any) for system design and development. It is not intended that the current contract be modified.

However, following system delivery, Sections XX and YY should be applied to subsequent work scope (e.g. maintenance, upgrade, etc.).

This Product Quality Plan defines the risk-tailored quality assurance elements that will ensure this system conforms to requirements. This plan will be updated as necessary – to ensure that it covers key QA activities throughout the system's life cycle.

The planned quality assurance elements that will be implemented during this system's life cycle fall into the following major categories:

- Quality Requirements for Supplier Implementation
- Qualification of Supplier
- Supplier Surveillance Activities
- Product Acceptance
- Storage, Testing, Installation, Operation and Maintenance

Note: Significant quality assurance activities identified in this plan will be added to the SOFIA project schedule – showing linkage to other project activities.

Quality Requirements for Supplier Implementation

1. Specifications and Standards ☐ Yes ☐ No

The following product and process standards and specifications (e.g. ANSI/ESD-S20.20 – ESD Control, NASA STD 2202-93 – Software Inspections, etc.) should be invoked in:

- Subsequent NASA and support contractor procurement documents related to CDDS maintenance, upgrade, modification etc.
- Internal work authorizing documents (e.g fabrication shop Work Orders, installation procedures, etc.).
  - ☐ NPD 8730.1 – Metrology and Calibration
  - ☐ NPD 8730.2 – NASA Parts Policy
  - ☐ NPR 8735.1 – Government Industry Data Exchange Program (GIDEP)
  - ☐ NASA-STD-8739.1 – Conformal Coating
  - ☐ NASA-STD-8739.2 – Surface Mount
  - ☐ NASA-STD-8739.3 – Soldering
  - ☐ NASA-STD-8739.4 – Cabling and Crimping

- ☐ NASA-STD-8739.5 – Fiber Optics
- ☐ ANSI/ESD-S20.20 – ESD Control
- ☐ NPR 7150.2 – NASA Software Engineering Requirements
- ☐ NASA-STD-2202 – Software Formal Inspections Standard
- ☐ NASA-STD-8739.8 – Software Assurance Standard
- ☐ NASA-GB-8719.13 – NASA Software Safety Guidebook (Non-Mandatory Guidance)
- ☐ DCP-S-007 – Software Assurance

2. Quality System Requirements For Contracts / Purchase Orders ☐ Yes ☐ No

NASA and support contractor procurement documents should require that:

- The supplier's quality system comply with AS9100.
- The supplier flow down, and verify that key sub-suppliers comply with:

QMS Standard	Products / Services Supplied
AS9100	• Design and development of systems / sub-systems / assemblies.
ISO 9001	• Fabrication of EEE components / assemblies. • Special processes (e.g. heat treatment, welding, plating, composite lay-up, etc.). • Non-Destructive Examination (e.g. radiography, dye penetrant, ultrasound, etc.). • Distributors of components for incorporation into flight hardware.
AS9003	• Machine shops.
ISO 17025	• Testing labs. • Calibration labs.

3. Supplier's Project Quality Plan ☐ Yes ☐ No

NASA procurement documents should require that the supplier submit a Project Quality Plan for DFRC **Project QA** approval. The supplier's Project Quality Plan must identify:

a) How the supplier's existing quality system will be tailored for this project.

b) The documented procedures that will be applied, or developed, for key project elements.

c) Any industry or company proprietary technical standards and specifications that have been identified by the supplier for application.

d) The type and timing of key technical reviews.

e) How processes will be controlled, and how products will be verified, including:
   - A flow chart showing monitoring, control and verification points.
   - Identify methods, frequency and criteria for these process control and product verification points.

f) The personnel, production and NDE processes to be certified.

g) Any new or upgraded production, NDE or measurement capability that may be necessary.

h) Anticipated sub-contracts for key elements of the supplier's contracted work scope – and the supplier's plan for the qualification and control of these sub-suppliers.

4. Deliverable Documents and Records ☐ Yes ☐ No

NASA and support contractor procurement documents should require that the supplier deliver the following documented procedures for **Project QA** approval:

- Hardware acceptance test procedures
- Software acceptance test procedures

NASA and support contractor procurement documents should require that the supplier deliver the following documents:

- Product drawings and referenced specifications.
- Installation, operation and maintenance manuals

NASA and support contractor procurement documents should require that the supplier deliver the following conformity records:

- Hardware acceptance test reports
- Software acceptance test reports
- Operating hours and cycles logs
- Limited life items logs

Qualification of Supplier

5. **Pre-Award Quality System Assessment**	☐ Yes	☐ No

☐ The supplier's third party AS9100 certificate will be obtained, and reviewed by **Project QA** to ensure that it covers the contracted work scope.

☐ **Project QA** will research the agency's Supplier Assessment System (SAS) database for relevant supplier audit reports and quality performance data.

☐ The supplier's quality system will be audited to assess:

- Its effectiveness in consistently achieving product and service conformance to requirements.
- Compliance with AS9100.

Proposed Supplier Corrective Action Requests will be coordinated with the Project.

Supplier Surveillance Activities

6. **Periodic Quality System Audit**	☐ Yes	☐ No

The supplier's quality system will be audited annually, unless supplier performance warrants a different frequency. Rationale for other than annual re-audit:

Significant changes may also warrant re-audit, such as:

a) The supplier's facility has been relocated – e.g. infrastructure, process equipment, work force and sub-suppliers may all have changed.

b) The supplier's facility has been significantly damaged by storm, flood, fire, mishap, etc.

c) The supplier's facility or work force has significantly changed – e.g. a second shift was added, key process equipment was moved or re-configured, etc.

d) The supplier's scope of work has significantly expanded – e.g. outsourced work was brought in-house, contract work scope was broadened, etc.

e) Planned or recent mergers, downsizing, significant outsourcing, labor actions, etc.

f) Significant changes in the type or frequency of product nonconformities, mishaps, test failures that may affect project safety, functionality, cost or schedule.

7. **Qualification of Key Sub-Suppliers**	☐ Yes	☐ No

The following safety or mission-critical work scope is expected to be sub-contracted:

•

Project QA will participate in the supplier's audit of the following sub-suppliers:

•

Project QA will review the supplier's qualification results for the following sub-suppliers:

•

8. Participate in Technical Reviews ☐ Yes ☐ No

Project QA will participate in requirements reviews, design reviews, readiness reviews, etc:

- Technical review issues identified by **Project QA** will be documented for disposition, status tracking and closure.
- **Project QA** will ensure that authorization to proceed to the next phase is only given if essential S&MA elements have been adequately addressed.

9. Qualification of Key Production and NDE Processes ☐ Yes ☐ No

It is anticipated that the following "Special Processes" will be used (e.g. welding, radiography, ESD control):

-
-

Special Processes require: 1) Qualification of process parameters, 2) Monitoring of process parameters and product characteristics and/or 3) Certification of personnel proficiency. Prior to the use of Special Processes, **Project QA** will review the supplier's:

- Process qualification requirements and results.
- Process Control Plan, including:
  - Which process parameters and product characteristics will be monitored.
  - Planned frequency and method for monitoring (e.g. in-line measurement, lab analysis).
- Personnel certification requirements and results.

10. Verify Work Force Competencies ☐ Yes ☐ No

Project QA will:

- Review the supplier's requirements for key high skill job classifications (e.g. internal job descriptions & SOWs for any sub-contract labor).
- Review associated personnel records to verify conformity with requirements for education, training, relevant experience, certifications, etc.

For high-skill work, factors that may adversely affect quality include:

- Excessive reliance on temporary personnel.
- Prolonged periods where work weeks significantly exceed 40 hours.
- Planned or recent mergers, downsizing, outsourcing, labor actions, etc.

11. In-Plant Surveillance ☐ Yes ☐ No

The following in-plant quality assurance surveillance will be arranged at the following location:

- Frequency (e.g. monthly, full-time):
- Performed by (e.g. DFRC, DCMA, NCAS):
- To include (e.g. process audit, product inspection, records review, etc.):

12. Supplier MRB ☐ Yes ☐ No

☐ Supplier will be granted MRB authority for "Use As-Is", "Repair" and "Regrade" dispositions of nonconforming product – without NASA review or approval.

☐ **Project QA** will review and approve supplier's "Use As-Is", "Repair" and "Regrade" dispositions of nonconforming product before implementation. **Project QA** will coordinate appropriate DFRC internal review of such dispositions by System Safety, Chief Engineer, Operations Engineering, etc. – to en-

sure that essential safety margins and operability are not compromised.

13. Monitor Product Nonconformance Reports ☐ Yes ☐ No

Nonconformance Reports (NCR) initiated by the supplier will be monitored by **Project QA** to ensure that they:

- Define the authorized disposition with adequate detail – e.g. "Rework per Procedure 987-6".
- Define appropriate re-inspection methods and acceptance criteria.
- Provide a suitable, documented design rationale for "Use As-Is" and "Repair" dispositions.
- Provide a suitable documented rationale if no corrective action will be initiated to eliminate root causes – to preclude additional similar deficiencies.

14. Monitor Supplier's Metrics for Patterns or Trends ☐ Yes ☐ No

Supplier will regularly submit, and **Project QA** will review, operational metrics – to identify patterns or trends in:

☐ Mishap reports.
☐ Internal and sub-supplier audit findings.
☐ Internal and sub-supplier corrective action requests.
☐ Product nonconformance / discrepancy reports.
☐ Design changes.
☐ Other:

Significant changes in supplier metrics will be evaluated by **Project QA** to determine if changes in the type or frequency of oversight and/or in-plant surveillance are warranted.

Product Acceptance

15. Hardware & Software Verification (GMIPS) ☐ Yes ☐ No

For each Government Mandatory Inspection Point (GMIP), **Project QA** will:

- Communicate the list of GMIPs to the supplier.
- Request the supplier to provide at least one week's notification of inspection/test performance.
- Review supplier's inspection and test procedures before implementation, and identify the specific steps for which a Government Representative must be present.
- Ensure that the necessary Government conformity verifications are completed, as defined in the applicable DFRC Inspection / Test Report.
- Review supplier's inspection and test results.
- Record GMIP results in the applicable DFRC Inspection / Test Report format.

The following software in-process and First Article verifications will be witnessed by **Project QA** in the supplier's facility as Government Mandatory Inspection Points (GMIPs):

-
-

The following hardware in-process and First Article inspections will be witnessed or performed by **Project QA** in the supplier's facility as Government Mandatory Inspection Points (GMIPs):

-
-

The following hardware in-process and First Article tests will be witnessed by **Project QA** in the supplier's facility as Government Mandatory Inspection Points (GMIPs):

-

•

16. Receiving Inspection ☐ Yes ☐ No

Receiving inspection will be witnessed by **Project QA**. Acceptance of delivered product will be based on:

☐ Verification that article packaging, dunnage and shipping containers are appropriate (e.g. ESD bags, desiccant, connector covers, impact monitors, etc.).

☐ Absence of visible damage to packaging and product.

☐ Verification of correct product identity and quantity, including accompanying:

- Interfacing components, cables, fasteners, covers, etc.
- Operation logs, limited life logs, etc.
- Manuals, procedures, records, etc.

☐ **Project QA** review of delivered products to verify conformance to requirements (e.g. Contract SOW, Quality Attachments).

☐ **Project QA** review of delivered documents and records to verify conformance to requirements (e.g. test reports, certifications, exposed radiography film, test coupons).

☐ Limited functional test of key system elements.

☐ Other:

Storage, Testing, Installation and Maintenance by DFRC

17. Storage of Flight Hardware and Interfacing GSE by DFRC

Delivered flight hardware and interfacing ground support systems will be placed into access controlled Bonded Stores prior to testing, installation or use. **Project QA** will witness storage conditions and verify their adequacy, including:

a) Identification of product with its part number and revision, serial number, and acceptance status.

b) Use of original packaging and shipping containers, or appropriately designed replacements.

c) Protection from environmental damage:

- Fire, dust/dirt, vermin, etc.
- Temperature and humidity control.
- Grounding for lightening strikes and ESD control.

d) Protection from tipping, bumping, and other impact / handling damage.

e) Provision for integrity monitoring, every 3 months, during extended storage periods.

f) Other:

18. Processing / Testing / Installation / Upgrade / Maintenance by DFRC

Before work initiation, documented procedures for processing, testing, installation, upgrade, maintenance, etc. will be reviewed and approved by **Project QA** to ensure that:

a) The work to be performed is defined at an adequate level of detail.

b) Applicable safety cautions are included.

c) Appropriate readiness reviews are inserted prior to critical work steps.

d) Applied torques, and calibration and shelf life expiration dates, are required to be recorded.

e) **Project QA** verification points are identified at key work steps, including:

- Verifications that can be performed during or shortly after work step performance.
- Mandatory hold points, which may not be performed without **Project QA** present.

f) Each documented procedure contains a final **Project QA** approval of the as-run procedure – to verify:

- Uncompleted or out of sequence steps have been appropriately authorized.
- Required data was recorded.
- Anomalies were appropriately documented (e.g. Discrepancy Report).
- Any nonconforming product is identified and controlled.

(**End**)